Summary

According to a first aspect of the present invention, there is provided a gas turbine engine, comprising: a compressor; a turbine; a static structure; a foil bearing system operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure, wherein the foil bearing system includes a foil bearing and a self-aligning foil bearing mount coupled to the foil bearing, wherein the self-aligning foil bearing mount is operative to align the foil bearing with an axis of rotation of the at least one of the compressor and the turbine; a snubber operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure in parallel with the foil bearing, wherein the self-aligning foil bearing mount includes at least two components configured to align the foil bearing by sliding displacement between the at least two components; wherein the foil bearing system is configured to prevent a rotation of the at least two components of the self-aligning foil bearing mount about the axis of rotation of the rotor; and wherein the self-aligning foil bearing mount is a spherical bearing, a first one of the at least two components of the bearing mount includes a convex crown having a spherical shape and being circumferentially disposed about the axis of rotation of the rotor and a second one of the at least two components is a concave receiver surface having a spherical shape, wherein the concave receiver surface receives the convex crown to permit the sliding displacement between the at least two components, wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

According to second aspect of the present invention, there is provided a gas turbine engine, comprising: a rotor; a static structure; a foil bearing system operative to transmit rotor loads from the rotor to the static structure, wherein the foil bearing system includes: a foil bearing; and a self-aligning foil bearing mount operative to align the foil bearing with an axis of rotation of the rotor, wherein the self-aligning foil bearing mount has a static component and a movable component; and wherein the self-aligning foil

bearing mount is operable to self-align with the axis of rotation of the rotor by sliding displacement of the movable component relative to the static component; wherein the foil bearing system is configured to prevent a rotation of the movable component about the axis of rotation of the rotor; and wherein the self-aligning foil bearing mount is a spherical bearing, the movable component of the bearing mount is a convex crown having a spherical shape and the static component is a concave receiver surface having a spherical shape, wherein the concave receiver surface receives the convex crown to permit the sliding displacement of the movable component relative to the static component wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor; wherein the movable component is configured such that the rotation of the movable component is the rotation of the entirety of the movable component.

According to a third aspect of the present invention, there is provided a foil bearing system for a gas turbine engine, comprising: a foil bearing operative to transmit rotor loads from a rotor of the gas turbine engine to a static structure of the gas turbine engine; and means for capturing and aligning the foil bearing with an axis of rotation of the rotor wherein the means for capturing includes a mount with a convex crown circumferentially disposed about the axis of rotation; wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

One embodiment of the present invention is a unique gas turbine engine. Another embodiment is a unique gas turbine engine foil bearing system. Other embodiments include apparatuses, systems, devices, hardware, methods, and combinations for gas turbine engines and gas turbine engine bearing systems. Further embodiments, forms, features, aspects, benefits, and advantages of the present application shall become apparent from the description and figures provided herewith.

CLAIMS:

1. A gas turbine engine, comprising:

a compressor;

a turbine;

a static structure;

a foil bearing system operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure, wherein the foil bearing system includes a foil bearing and a self-aligning foil bearing mount coupled to the foil bearing, wherein the self-aligning foil bearing mount is operative to align the foil bearing with an axis of rotation of the at least one of the compressor and the turbine;

a snubber operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure in parallel with the foil bearing,

wherein the self-aligning foil bearing mount includes at least two components configured to align the foil bearing by sliding displacement between the at least two components;

wherein the foil bearing system is configured to prevent a rotation of the at least two components of the self-aligning foil bearing mount about the axis of rotation of the rotor; and

wherein the self-aligning foil bearing mount is a spherical bearing, a first one of the at least two components of the bearing mount includes a convex crown having a spherical shape and being circumferentially disposed about the axis of rotation of the rotor and a second one of the at least two components is a concave receiver surface having a spherical shape, wherein the concave receiver surface receives the convex crown to permit the sliding displacement between the at least two components, wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

2. The gas turbine engine of claim 1, wherein the self-aligning foil bearing mount includes a static component and a movable component, and wherein the self-aligning foil

bearing mount is operable to self-align by displacing the movable component relative to the static component.

3. The gas turbine engine of claim 2, wherein the movable component is operable to rotate relative to the static component.

4. The gas turbine engine of claim 3, wherein rotation of the movable component is rotation of the entirety of the movable component.

5. The gas turbine engine of claim 2, wherein the static component includes a first surface; wherein the movable component includes a second surface in sliding contact with the first surface; and wherein displacement of the movable component relative to the static component includes the second surface sliding against the first surface.

6. The gas turbine engine of claim 2, wherein self-alignment is not achieved by flexure of the self-aligning foil bearing mount.

7. The gas turbine engine of claim 1, further comprising a shaft coupled to at least one of the compressor and the turbine, wherein rotor loads are transmitted from the shaft through the foil bearing, and from the foil bearing to the static structure via the self-aligning foil bearing mount.

8. The gas turbine engine of claim 7, wherein the shaft couples the compressor to the turbine.

9. The gas turbine engine of claim 1, further comprising a rotating journal and a housing disposed opposite to the rotating journal, and wherein the snubber is operative to limit the proximity of the housing relative to the journal.

10. A gas turbine engine, comprising:

a rotor;

a static structure;

a foil bearing system operative to transmit rotor loads from the rotor to the static structure, wherein the foil bearing system includes:

a foil bearing; and

a self-aligning foil bearing mount operative to align the foil bearing with an axis of rotation of the rotor, wherein the self-aligning foil bearing mount has a static component and a movable component; and wherein the self-aligning foil bearing mount is operable to self-align with the axis of rotation of the rotor by sliding displacement of the movable component relative to the static component;

wherein the foil bearing system is configured to prevent a rotation of the movable component about the axis of rotation of the rotor; and

wherein the self-aligning foil bearing mount is a spherical bearing, the static component of the bearing mount is a convex crown having a spherical shape and the movable component is a concave receiver surface having a spherical shape, wherein the concave receiver surface receives the convex crown to permit the sliding displacement of the movable component relative to the static component wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

11. The gas turbine engine of claim 10, further comprising a snubber operative to transmit rotor loads from the rotor to the static structure in parallel with the foil bearing.

12. The gas turbine engine of claim 11, further comprising a bearing housing for housing the foil bearing, wherein the snubber is positioned within the bearing housing.

13. The gas turbine engine of claim 12, wherein the snubber is positioned adjacent to the bearing housing.

14. The gas turbine engine of claim 12, wherein the snubber is formed of a composite material.

15. The gas turbine engine of claim 10, wherein the foil bearing is a compliant foil radial air bearing.

16. A foil bearing system for a gas turbine engine, comprising:

a foil bearing operative to transmit rotor loads from a rotor of the gas turbine engine to a static structure of the gas turbine engine; and

means for capturing and aligning the foil bearing with an axis of rotation of the rotor wherein the means for capturing includes a mount with a convex crown circumferentially disposed about the axis of rotation;

wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

17. The foil bearing system of claim 16, further comprising means for sharing the rotor loads with the foil bearing.

18. The foil bearing system of claim 16, wherein the means for aligning includes a spherical bearing.

19. The gas turbine engine of claim 1, wherein the foil bearing is positioned directly adjacent the foil bearing mount; and

the snubber is positioned behind a top foil such that rotor loads are first transmitted through the top foil and then to the snubber.

20. The gas turbine engine of claim 10, wherein the foil bearing is positioned directly adjacent the foil bearing mount; and

the snubber is positioned behind a top foil such that rotor loads are first transmitted through the top foil and then to the snubber.

Claims:

1. A gas turbine engine, comprising:

a compressor;

a turbine;

a static structure;

a foil bearing system operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure, wherein the foil bearing system includes a foil bearing and a self-aligning foil bearing mount coupled to the foil bearing, wherein the self-aligning foil bearing mount is operative to align the foil bearing with an axis of rotation of the at least one of the compressor and the turbine;

a snubber operative to transmit rotor loads from at least one of the compressor and the turbine to the static structure in parallel with the foil bearing,

wherein the self-aligning foil bearing mount includes at least two components configured to align the foil bearing by sliding displacement between the at least two components;

wherein the foil bearing system is configured to prevent a rotation of the at least two components of the self-aligning foil bearing mount about the axis of rotation of the rotor; and

wherein the self-aligning foil bearing mount is a spherical bearing, a first one of the at least two components of the bearing mount includes a convex crown having a spherical shape and being circumferentially disposed about the axis of rotation of the rotor and a second one of the at least two components is a concave receiver surface having a spherical shape, wherein the concave receiver surface receives the convex crown to permit the sliding displacement between the at least two components, wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

2. The gas turbine engine of claim 1, wherein the self-aligning foil bearing mount includes a static component and a movable component, and wherein the self-aligning foil bearing mount is operable to self-align by displacing the movable component relative to the static component.

3. The gas turbine engine of claim 2, wherein the movable component is operable to rotate relative to the static component.

4. The gas turbine engine of claim 3, wherein rotation of the movable component is rotation of the entirety of the movable component.

5. The gas turbine engine of claim 2, wherein the static component includes a first surface; wherein the movable component includes a second surface in sliding contact with the first surface; and wherein displacement of the movable component relative to the static component includes the second surface sliding against the first surface.

6. The gas turbine engine of claim 2, wherein self-alignment is not achieved by flexure of the self-aligning foil bearing mount.

7. The gas turbine engine of claim 1, further comprising a shaft coupled to at least one of the compressor and the turbine, wherein rotor loads are transmitted from the shaft through the foil bearing, and from the foil bearing to the static structure via the self-aligning foil bearing mount.

8. The gas turbine engine of claim 7, wherein the shaft couples the compressor to the turbine.

9. The gas turbine engine of claim 1, further comprising a rotating journal and a housing disposed opposite to the rotating journal, and wherein the snubber is operative to limit the proximity of the housing relative to the journal.

10. A gas turbine engine, comprising:

a rotor;

a static structure;

a foil bearing system operative to transmit rotor loads from the rotor to the static structure, wherein the foil bearing system includes:

a foil bearing; and

a self-aligning foil bearing mount operative to align the foil bearing with an axis of rotation of the rotor, wherein the self-aligning foil bearing mount has a static component and a movable component; and wherein the self-aligning foil bearing mount is operable to self-align with the axis of rotation of the rotor by sliding displacement of the movable component relative to the static component;

wherein the foil bearing system is configured to prevent a rotation of the movable component about the axis of rotation of the rotor; and

wherein the self-aligning foil bearing mount is a spherical bearing, the movable component of the bearing mount is a convex crown having a spherical shape and the static component is a concave receiver surface having a spherical shape, wherein the concave

receiver surface receives the convex crown to permit the sliding displacement of the movable component relative to the static component wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor;

wherein the movable component is configured such that the rotation of the movable component is the rotation of the entirety of the movable component.

11. The gas turbine engine of claim 10, further comprising a snubber operative to transmit rotor loads from the rotor to the static structure in parallel with the foil bearing.

12. The gas turbine engine of claim 11, further comprising a bearing housing for housing the foil bearing, wherein the snubber is positioned within the bearing housing.

13. The gas turbine engine of claim 12, wherein the snubber is positioned adjacent to the bearing housing.

14. The gas turbine engine of claim 12, wherein the snubber is formed of a composite material.

15. The gas turbine engine of claim 10, wherein the foil bearing is a compliant foil radial air bearing.

16. A foil bearing system for a gas turbine engine, comprising:

a foil bearing operative to transmit rotor loads from a rotor of the gas turbine engine to a static structure of the gas turbine engine; and

means for capturing and aligning the foil bearing with an axis of rotation of the rotor wherein the means for capturing includes a mount with a convex crown circumferentially disposed about the axis of rotation;

wherein the convex crown is configured to rotate about an axis of rotation that is perpendicular to the axis of rotation of the rotor.

17. The foil bearing system of claim 16, further comprising means for sharing the rotor loads with the foil bearing.

18. The foil bearing system of claim 16, wherein the means for aligning includes a spherical bearing.

19. The gas turbine engine of claim 1, wherein the foil bearing is positioned directly adjacent the foil bearing mount; and

the snubber is positioned behind a top foil such that rotor loads are fist transmitted through the top foil and then to the snubber.

20. The gas turbine engine of claim 10, wherein the foil bearing is positioned directly adjacent the foil bearing mount; and

a snubber is positioned behind a top foil such that rotor loads are first transmitted through the top foil and then to the snubber.